



Munich Personal RePEc Archive

## **Evolutionary Political Economy: Content and Methods**

Hanappi, Hardy and Scholz-Waeckerle, Manuel

University of Technology of Vienna, University of Economic and Business Administration of Vienna

31 October 2015

Online at <https://mpra.ub.uni-muenchen.de/75447/>

MPRA Paper No. 75447, posted 07 Dec 2016 14:29 UTC

## Evolutionary Political Economy: Content and Methods

---

Hardy Hanappi<sup>®</sup> and Manuel Scholz-Wäckerle<sup>®</sup>

### Abstract

In this paper we present the major theoretical and methodological pillars of evolutionary political economy. We proceed in four steps.

**Aesthetics:** In chapter 1 the immediate appeal of evolutionary political economy as a specific scientific activity is described.

**Content:** Chapter 2 explores the object of investigation of evolutionary political economy.

**Power:** The third chapter develops the interplay between politics and economics.

**Methods:** Chapter 4 focusses on the evolution of methods necessary for evolutionary political economy.

The conclusion positions the field of evolutionary political economy – as we proposed to establish it in this paper - within the wider area of scientific activity. In particular, demarcation lines towards some fashionable economic schools (institutionalism, behavioural economics, post-Keynesianism, etc.) are indicated.

Keywords: Evolutionary Theory, Political Economy, Methodology of Social Sciences

---

<sup>®</sup> Vienna University of Technology – Institute for Mathematical Methods in Economics – Research Group Economics, [hanappi@econ.tuwien.ac.at](mailto:hanappi@econ.tuwien.ac.at)

<sup>®</sup> Vienna University of Economics and Business – Department Socioeconomics – Institute for the Environment and Regional Development, [manuel.waeckerle@wu.ac.at](mailto:manuel.waeckerle@wu.ac.at)

## Introduction

A spectre is haunting Europe, the spectre of *Capitalism*. To paraphrase Marx famous evaluation of Europe's political situation in the middle of the 19<sup>th</sup> century quite accurately describes the current turmoil of European politics. Extreme unemployment rates, an extremely fragile financial architecture, a renaissance of fascism and nationalism in several forms and many countries, all that seems to be further spurred by the spectre of capitalism. But while actual capitalism is omnipresent, its scientific justification, the ideology of the ruling class, so-called mainstream economics, is describing general equilibrium worlds that are completely decoupled from what happens here. Capitalist decision-makers in European governments are left alone and are desperately trying to extract some knowledge from these empty formalisms. The danger is that the spectre of capitalism is transforming into the spectre of fascism again.

In this rather dramatic environment this paper proposes the research program of *evolutionary political economy* (EPE) as a means to understand the current situation, eventually even to serve as a guide for political intervention. To do so we are starting with a chapter on the aesthetic appeal of EPE following the (Hegelian) idea that you have to seduce young intellectuals to be attracted by the sea of knowledge to go into the water and learn swimming. Once they are in they are learning to swim by their own thoughts. The following chapters then describe the interplay between content of EPE, the power relations it describes, and the formalisms it will apply. In the conclusion we wrap these streams together and position our research program vis-à-vis other heterodox approaches. Though this text often remains to be further specified and elaborated, we nevertheless hope to convince our readers to join the theoretical work along the lines we propose.

## 1. Aesthetics

Evolutionary political economy (EPE) is an aesthetically appealing field of scientific activity. In the language of today's youth: EPE is epic. There are several reasons for this property of EPE, the most important ones can easily be described.

First of all, it is immediately visible that EPE is just the latest part of the grand approach of evolutionary theory, of a theory that aims to explain the emergence and further development of life forms, of living systems<sup>1</sup>. This high aspiration, more precisely to be an important piece in the mosaic of such a ground-breaking scientific project, is extremely stimulating. Even if the individual researcher feels small when compared to the enormous task ahead<sup>2</sup>, there nevertheless is an atmosphere of contributing to something substantial. This feeling exists independently of a rational evaluation of the capacity of the researcher, even without knowing too much about what already has been achieved; it is just a pre-rational feeling – and that is exactly what the classic notion of aesthetics is defining. So from this vantage point it is the *grandeur of the scientific activity* to which EPE belongs that contributes to the experienced beauty.

---

<sup>1</sup> In the 19<sup>th</sup> century Charles Darwin was adding evolutionary theory as a proper scientific activity to the already existing successful natural sciences. Though it first was focussing on biology it nevertheless immediately implied a new image of the human species.

<sup>2</sup> Note that Erwin Schrödinger, one of the greatest scientists of his time, only dared to give his lecture 'What is Life' when he was already a well-established star in the scientific arena.

Contrary to a common misunderstanding beauty does not lie in the eye of the beholder<sup>3</sup>, even the extension that it lies in the *mind* of the beholder is still misleading. The experience of beauty rather occurs in the process of interaction with something outside the individual mind. It is a property of a special type of dialogue<sup>4</sup>, more precisely an interaction that leads beyond the communication level of a dialogue, leads from metaphysical action to physical action. It is the *mirror* that certain types of beautiful interaction enable, that they indeed create, which is attractive. Evolutionary political economy is a theoretical object of investigation that puts the individual researcher in front of the mirror that shows the evolution of the whole human species. His or her own evolution, Hegel called it 'Werden' (becoming), is reflected as part of the larger social process. This typically has been stated as becoming conscious that the observer is part of the observation. It involves a special role of the social scientist, namely to take time serious, to be able *to shape the future of social evolution*. This *new type of power* is the core of the attractiveness of the beautiful interaction of doing EPE. The natural sciences that emerged in the 17<sup>th</sup> century only indirectly contributed to this task by *discovering* laws of nature that could be cleverly exploited by the respective ruling classes to enhance their power – and thus stimulate further social revolutions as the limits of old class settings became visible faster. Evolutionary political economy, emerging in the 19<sup>th</sup> century, sets out to shape social evolution directly. The arrow of time that occurs in the theoretical physics only in the 2<sup>nd</sup> law of thermodynamics and points in the direction of ever increasing disorder and properties of elements that approach the average, this arrow of time now is inverted by EPE, pointing to more and more sophisticated and specialized social organisation, to consciously shaped order (including the 'disorder' produced by innovation). Instead of discovering laws (like the natural sciences) EPE now puts time at the centre of its conceptual apparatus and (1) uses history to study the evolution of social laws shaping the respective era, (2) introduces welfare of the human species as a goal function for inventing new social laws, and (3) proposes ways to implement these welfare enhancing social laws. The researcher in EPE leaves the ivory tower (or sterile laboratory) of the natural scientist and steps out into the exciting arena of political struggle for a better life for all<sup>5</sup>. This is a beautiful experience.

Closely related to the just mentioned dimension of aesthetics is another pole of attraction: Evolutionary political economy is neither focussing on too singular processes nor on too general issues. *It focusses on the 'particular'* (Hegel's 'das Besondere') that lies in between. The general and eternally valid law of structural sciences like mathematics that makes its discoverer eternal is a non-token as is the singular highly specialized work of a researcher developing a drug for a pharmaceutical firm – making this singular contribution invisible. The researcher and the contribution are less separated, neither the most improbable case of an eternal discovery nor a standard case of invisibility are the rule. Investigators in EPE can zoom-in or zoom-out with respect to their object of

---

<sup>3</sup> This would dissolve beauty into the arbitrariness of the observing mass of human individuals.

<sup>4</sup> German Idealist Thought, e.g. Kant, had reduced the experience of beauty to a special type of idle observation of an object possessing the property to be beautiful. To gain a sharper criterion for beautiful objects a fierce debate on the need to exclude all useful objects, all tools, from the domain of beautiful objects was emerging. But the question 'What was to be considered as a tool?' referred back to the observer - the observer 'without interest in the object' was invented. Aesthetics typically was conceptualized for the members of a ruling class to encompass their leisure time activities. This is in sharp contrast to the concept of aesthetics used here.

<sup>5</sup> Max Weber started a desperate attempt to ignore this essential difference by postulating a distinction between 'objective statements' and 'normative statements' that a social scientist has at his/her disposal. The 'objective' ones were meant to have the same status as natural laws, whereas the 'normative' ones were choices of the researcher based on individual attitudes or moral feelings. Despite the evident lack of scientific significance – see the arguments above – till today a considerable part of researchers in the natural sciences falls prey to Weber's view.

investigation. They also might be panning their camera freely, more to the past or more towards social designs for the future. In doing so the community of EPE researchers nevertheless remarks the *reappearance of generality*: it reappears as the pattern of evolution-revolution-evolution-revolution-... Zooming-in on the time axis, on a particular era when a particular sequence of this pattern is occurring, reveals the particular mechanics of continuity and break. Why is such a research aesthetically attractive? Consider everyday life: Waves of routine steadily undermine a rock of dissatisfaction with routine achievements at which they break. At some point in time the rock falls and within a short time a new constellation emerges, new types of waves roll again against a new rock. See the answer to the question? It's only Rock & Roll, and I like it! Or, taking an alternative route to the experience of beauty, note Adorno's famous remark that 'the break is the signum of modernity'. EPE is *modern aesthetics*<sup>6</sup> since its generality reappears as the fractal structure of investigations into breaks between styles of social evolution. EPE as a form of modern art certainly is a refreshing perspective to start with. But, of course, the *singular reappears* too: The way it does is rather surprising since it builds on the fact that the researcher 'steps out into the exciting arena of political struggle' (see last paragraph). This step always is a singular step, in other words the researcher in each single case has to distinguish short-run tactics and mid-run strategy. Again this reappearance of the extreme form of singularity in EPE research corresponds closely to what scientists experience in their private life: Two time scales of tactics and strategy linked together into one time scale of a decision scenario<sup>7</sup>. The focus on the 'particular' thus makes evolutionary political economy research activity very similar to what affects individual scientists in their private life. There is an aesthetic gain based on recognizing this similarity.

Finally there is an *aesthetic quality of evolutionary political economy* that stems from *the formalization needs which it entails*. It is interesting to take a look at the type of formalization that mainstream economics celebrates. At the core the mainstream uses general equilibrium theory of markets, which is formalized as a re-interpretation of the (partly stochastic) general equilibrium theory in mechanics as developed by theoretical physics in the late 19<sup>th</sup> century. This re-interpretation goes back to the ideas of Leon Walras in 1874 as they were finally refined by Kenneth Arrow and Frank Hahn in 1967. Though this apparatus in the last half century has been mathematically fine-tuned and today looks awfully complicated to understand, its content with respect to evolutionary political economy nevertheless is still ridiculously inadequate. Its basic features, in particular the complete neglect of limited internal model-building and communication of social entities, cannot be expected to be repaired. This mistaken pseudo-scientific framework of mainstream economics is the reason why the general public after the financial collapse of 2008 lost any trust in the science of economics – and rightly so. Even though the original in theoretical physics from which the copy was taken has experienced a theoretical quantum jump in the first decades of the 20<sup>th</sup> century (Einstein and then quantum physics) these events left stubborn proponents of mainstream economics unimpressed. John von Neumann's singular attempt to invent a new formal language for the social sciences, game

---

<sup>6</sup> All 'isms' that start with a 'post-' (post-modernism, post-Keynesianism, post-autism ...) just express that they are helpless to name what they can offer. They thus have to use the name of what they pretend to have overcome, and timidly add the pre-fix 'post' since their property to be later is their only *raison d'être*. Usually they are just minor updates or downgrades of the original. Evolutionary political economy is firmly rooted in modernity.

<sup>7</sup> The classic in this area was written by a German theorist of military strategy, Clausewitz [Clausewitz, 1834]. Till today fruitful theoretical work in this field comes from classic studies in warfare, e.g. the theory of Colonel Blotto Games.

theory<sup>8</sup>, remained incomplete and in the hands of his followers degenerated into a sub-discipline of standard mathematics. Only when the age of computer simulation started and this type of modelling became a respected member of the set of formalization tools, only then the renaissance of the formalization of evolutionary political economy became possible, became even necessary. With this tool the plethora of so-called ‘technical simplifications’ (e.g. assuming away all communication processes and limits of information processing capacities) became largely unnecessary, even internal model-building of sub-programs representing social entities could be mimicked. In the last decades evolutionary political economy entered a new era. This is exciting, and it leaves mainstream economics behind, since even its representatives are pre-occupied with the task to justify their obsolete results with the help of the new toolbox – if they accept the new tools at all. As this process becomes more visible with every year of crisis (in the global economy as well as in theory) even veterans in mainstream economics now start to re-emerge as EPE scholars. And here comes the aesthetic appeal: Social scientists of the younger generation grew up with new information and communication technologies; they all know how to program, they all saw the tremendous global change in life-style brought about by mobile telephones and the internet. For them the new toolbox of agent-based simulation – and the revival of game theory enabled by this toolbox – is not a terra incognita. This is their everyday formalization approach. Evolutionary political economy can thrive on the smart and easily understandable simulations its unique formalization device enables. And this technology-driven renaissance of EPE first only needs the high propensity of computer geeks to program! At this point the euphoria for the new dimension of aesthetic appeal badly needs a caveat. A formal language alone is always insufficient to guarantee adequate scientific modelling. (Preliminary) success always hinges on the combination of empirical observation and (eventually formal) scientific language. In the case of EPE this implies an analysis of the history of the respective political economy phenomenon as well as the force of abstraction necessary to propose new welfare-increasing solutions. In both respects computers increasingly help, but (so far) cannot replace genuine scientific work of the social scientist. Another, though even more speculative aspect of the general advance of science has to be mentioned that might constitute an additional aesthetic quality of EPE for some: Quantum physics has changed our view of the working of nature fundamentally – though the vast majority of social scientists seems to be not aware of this fact. At the research frontier of science, under the overlapping headers of ‘theoretical physics’ and ‘microbiology’ theory development is in turmoil. Even the implications of the classic formulation of quantum theory of the late 20-ties of the last century seem to be not fully understood. Can social science afford to ignore theoretical – and encompassing formal – developments in the natural sciences? Is it sufficient to work with (low order, stochastic) differential equation systems and toy models of computer simulations? Should the research frontier (in methods and content) not rather be shifted to areas where social science can actively learn from other sciences? Of course, it does not make sense just to copy certain formalisms and to redefine names of variables, like the general equilibrium theory procedure of the last century. But to get stimulated by the idea of the light-particle dualism, the probability issues of Heisenberg or the deep insight of the Pauli principle should be a good advice. For a handful of young researchers in evolutionary political economy it might feel well - aesthetically - to work eventually at the top of *all* science, conquering indeed a terra incognita.

---

<sup>8</sup> See [Hanappi, 2013b].

This little tour de force through arguments meant to convince young and old social scientists to study evolutionary political economy without knowing in the first place what it is, i.e. to provide an aesthetic approach to the field, this attempt now has to be followed by a description of the actual content of our field of science.

## 2. Content

All social science starts with a look back on the history of living systems, using an increasingly scientific language to describe it. This chapter concentrates on what is to be described, i.e. on history, while chapter 4 focusses on the evolution of the languages used. But social science is more than just a chronological description of what had happened in the past. To be a science means to elaborate the *essence* of what is historically observed. Simple perception has to be enriched by interpretation, i.e. by grafting patterns, a system of causal relationships, onto the chaos of impressions. By filtering received perceptions and proposing patterns as being essential, scientific work becomes useful for the society of which it is part of. The scientific proposal gains importance since it promises to guide actions to take advantage of patterns repeated in the future. The logic of ideas applied to filter observations therefore frames the current use of scientific results, in this sense all science carries an ideological component. If the scientific community is part of a society and its object of investigation is its political economy, which itself is constituted by different classes, then it is evident that also the use derived from science will point to different directions: The scientific community will fall apart, and pretty much so along the lines of class divisions<sup>9</sup>.

What makes our approach to evolutionary political economy a very special approach is that its long-run orientation makes it possible to make emergence and disappearance of classes, i.e. their finite dynamics<sup>10</sup>, part of the theory itself. The particular interpretation of these finite dynamics as *evolutionary* dynamics hints at Darwin's approach in biology: The evolution of species, i.e. emergence, adaption, and disappearance of species, follows the changes of the environment these species live in, an environment that itself is continuously changing – and not the least so because of the activities of the species which it houses<sup>11</sup>. Evolutionary theory of living systems understood in this manner consists of both, biology and evolutionary political economy. As an immediate consequence the borderline between the two disciplines has to be discussed – from an evolutionary perspective, of course, namely as an endogenously emergent break.

But before this type of break is discussed it is useful to take a look at the break from non-living systems to living systems. This is interesting because current mainstream economic theory comes in a mathematical disguise that has been borrowed almost completely from 19<sup>th</sup> century mechanics

---

<sup>9</sup> The existence of different schools of economic theory is not just an indicator of a premature state of this science, it also reflects the fact that each social scientist is part of a specific social class. E.g. Keynes' theory implicitly accuses the class of rentiers while trying to save fragile finance capitalism from collapse with the help of the state faction of the ruling class. Keynes was personally involved in stock exchange activities.

<sup>10</sup> The concept '*finite dynamics*' shall indicate that these dynamics include entry and exit of variables, i.e. the property of variables to be essential for the dynamics is finite. To determine the set of variables sometimes has been considered as 'qualitative research', while the development of the quantities that a set of variables is assuming has been labelled 'quantitative research'. Evolutionary theory embraces the pulsation of the alternation of both.

<sup>11</sup> Darwin's view of mutual adaption as the source of continuing diversity was in stark contrast to the dominant ideology of the ruling classes of his time, Christianity, which interpreted the development of mankind as part of an asymptotic process towards an ideal devised by the church mirroring a supernatural being - God.

(compare [Smith and Foley, 2002]), a theory of non-living matter<sup>12</sup>. The two central laws of this ‘old physics’ go back to Newton and are known as the two laws of thermodynamics.

Roughly spoken, the first law of thermodynamics states that in a closed system the sum total of energy is constant. Note that this statement introduces two abstract concepts, which are immediately set in a strict relationship: The ‘closed system’ and the ‘sum of energy’. On the one hand it is explained what is to be seen as a *closed system*, namely a system in which the sum total of energy remains constant, a definition quite independent of the question if such a system exists. On the other hand the new concept *energy* is introduced as a measurable quantity, occurring in different forms, but due to its measurability open to aggregation. The different forms of energy and their laws of transformation (culminating in Einstein’s  $E = mc^2$ ) then clearly constitute the core of ‘old physics’. *Closure* and *quantitative constancy* therefore build the conceptual frame within which its laws – without a special role<sup>13</sup> of the concept of time – have been formulated.

To replace an evolutionary notion of time by a fully reversible time counter enables a mathematical treatment producing eternally valid laws (valid at the level of abstract thoughts, of course) that is of a fascinating rigorousness and clarity of issues. Mathematical treatment and the conjecture of physical science in practice often were the same process. Nevertheless the fact that physical science was not only rooted in rigorous mathematical methods but also in results from experimental laboratory work soon led to the discovery of the deficiencies that the elimination of evolutionary time had brought about: The description of dynamic developments of non-living matter remains unsatisfactory. As a remedy the first law of thermodynamics was amended by a second law of thermodynamics, which makes explicit use of the irreversibility of time in postulating a long-run increase of *entropy*. The newly introduced concept of ‘entropy’ again (like ‘energy’) describes a measurable property of the system<sup>14</sup>; but now the law does not refer to constancy and closure, it instead postulates a *stochastic* law of an (with time) *irreversibly increasing* entropy. Again this law links new concepts allowing for an interpretation in different causal directions. Underpinning the concept of entropy is the hypothesis that there is a dynamic microstructure that has to be modelled more in detail to allow for the understanding of the transition from one level of entropy to the next. A causal interpretation starting with this dynamic microstructure would then see a well-defined entropy is causing the decrease in entropy in the long-run. The other way round – and in parallel - the way in which structure is to be described can be seen as a consequence of the increasing disorder observed in the first place<sup>15</sup>.

But note that there is a third innovative element in this 2<sup>nd</sup> law of thermodynamics, the innocent-looking adjective ‘*stochastic*’. It expresses that a sequence of observations made over a finite time period might well contradict the law, it only is approached as time horizons become ever longer. With

---

<sup>12</sup> Today econophysics is so attractive for economists because it at least provides formalisms of *up-to-date* theoretical physics to be applied in economics. Every newly emerging field, like evolutionary political economy, should be eager to incorporate *appropriate* innovative language elements.

<sup>13</sup> Time is just a quantitative counter, each law works forward and backward in time, i.e. time is reversible.

<sup>14</sup> Entropy can be understood as a measure of how similar a certain set of properties (e.g. speed and average free path length) of elements (e.g. molecules) within a system (e.g. a gas in a vessel) is. What happens in the short-run remains in the dark of murky and complicated non-linear dynamic systems theory, but in the long-run the stochastic law of increasing entropy drives the set of properties to the same average values. The situation towards which the system converges clearly reminds on the assumption of the ‘representative firm’ in standard microeconomics.

<sup>15</sup> Already half a century ago Henri Theil had used this long-run averaging tendency to construct measures for economic inequality in distribution [Theil, 1967]. In this context the stochastic long-run tendency towards increasing entropy postulated in physics can be understood as a tendency towards equalisation of incomes in political economy. Might this be a stochastic, long-run measure of progress?



the introduction of this new irreversible time dimension finally *probability theory* entered the stage of scientific inquiry<sup>16</sup>. From that moment on the distinction between certainty and probability of issues concerning non-living systems started to frame what probability theory is about – right across the different jargons of cognitive science and epistemology and the distinction between deduction and induction. What has to be kept in mind is that till today standard probability theory follows the needs to describe non-living matter<sup>17</sup>.

At this point an important idea of the eminent physicist Erwin Schrödinger has to be mentioned. In his book ‘What is Life?’ [Schrödinger, 1944] he argues as follows: If the second law of thermodynamics is valid and if living systems are a subset of all systems (if living systems have a purely physical dimension), then it is straight forward to *characterize living systems as those systems that decrease entropy!* Since this is only possible as a counter-movement to the still valid 2<sup>nd</sup> law of thermodynamics, it can only occur during the finite time-span that the adjective ‘stochastic’ of this law permits. The phenomena of birth and death, i.e. begin and end of this time-span, are intrinsically linked to living systems. In between birth and death so-called negentropy can occur and processes can build-up structures and can organize the elements of the living system, which thus temporarily resists the long-run tendency of all matter. The details of how this is possible, of how the sequence of different steps of this resistance against increasing entropy emerge, this is precisely what evolutionary theory is trying to investigate. Today the physicist Erwin Schrödinger therefore often is considered to be one of the first ancestors of modern microbiology. In more profane words: Biology of fauna and flora is part of evolutionary theory as well as any social science. All parts of this science of living systems try to understand the steps of the build-up process of the order of systems – first descriptive only, later with the goal of using this knowledge for intervention in the future course of events. Charles Darwin’s pivotal insight was to direct the focus of research towards the fact that evolutionary processes are characterized by coming in rather abrupt steps – in time as well as in space. His concept of the species is used to name a certain step of an evolutionary development that takes place in a well-defined spatial environment during a well-defined time period. Where these steps come from, how a certain step makes the next one possible and probable, this is already announced as a major topic of research in the title of his book ‘The Origin of Species’ [Darwin, 1859]<sup>18</sup>.

It is interesting to consider how the two laws of thermodynamics (non-living systems) would look if they would be inverted, i.e. seen from the perspective of evolutionary theory (living systems). The negation of the closure of the system would be the self-generating sequence of ever-changing life forms. To get an idea of the negation of the constancy of energy a closer look at its role is necessary: It is a device to measure an abstract property ascribed to a particular observable. Moreover it shall be possible to aggregate, to sum-up the amounts of this property of different observables. The straight

---

<sup>16</sup> Ludwig Boltzmann has been the incarnation of this unity between ‘old physics’ and the new theoretical innovation of probability theory. By taking his new combination of the two theory fragments to the limit, he prepared the ground for ‘new physics’ – a perfect example of (Schumpeterian) innovation in science.

<sup>17</sup> Of course, these needs also are continuously changing. The newly emerging quantum electrodynamics induced several innovations in probability theory.

<sup>18</sup> Darwin’s view was a stark provocation of Christian ideology: He postulated that the progressive order systems of species are self-generated by these systems, a clear contradiction to the Christian dogma that the human species alone is on a long-run trail of catharsis to become ideal, i.e. the mirror image of God – and that this investigation is the central topic of science. Since Darwin knew how dangerous his work was for the Christian dogma he delayed the publication of his book for more than ten years. But even more important is that - like Marx with whom he had a friendly correspondence - Darwin recognized that it is typical for changes from one step to the next that this metamorphosis occurs in a relatively short time span. In Marx famous formulation: Revolutions are the fast trains of history (‘Revolutionen sind die Schnellzüge der Geschichte’).

forward negation in evolutionary theory at first sight is the non-constancy, the continuing, stepwise decrease of entropy<sup>19</sup>. But change of a measurable quantity needs more specification than the postulate of constancy, it asks for rules describing how the decrease takes place, how a more of structure is to be formalized. Instead of boiling down changes in structure to a single number it would be wise to refer here to the possibilities of algorithmic descriptions of the different living systems. Life forms are getting more and more sophisticated and complicated in their structures, their increasing complexity mirrors decreasing entropy. Steps of decrease come with steps of increase in complexity, and the latter can rather be imagined as steps in the size and structure of a network than as a jump in a single number. It is thus the sequence of stepwise increase of network complexity (described in algorithmic language, i.e. simulation) that takes the place of a negation of the concept of energy in the inverted 1<sup>st</sup> law of thermodynamics. Contrary to this evolutionary negation of closure and constancy of energy, mainstream general equilibrium theory is formulated precisely along the lines of non-living matter: In a closed space of commodity owners (closure) with measurable, well-behaved utility functions market forces produce a unique vector of exchange relations leading to a unique and constant optimal sum of utilities (constancy).

In the 2<sup>nd</sup> law of thermodynamics the three central new concepts were the *dynamic microstructure*, which has a measurable property called *entropy*, and the property of the rule to be a *stochastic* rule. Since it postulates a long-run continuous process its negation should start with a short-run stability consideration. How can a relatively stable stage that a living system in its development of order has reached be described<sup>20</sup>? On the one hand there must be stabilizing forces at work that drive the system back to its dominant structural setting if small disturbances from the environment disturb it. On the other hand the reasons for the metamorphosis to the next step must also be slowly developing during the still stable current step. Somehow their still inessential accumulation and slowly accelerating visibility must also be an endogenous element of the current stage. Each stage thus contains stabilizing as well as destructive forces – and they are linked to each other. The inversion of the 2<sup>nd</sup> law therefore leads to the introduction of a new central concept: *contradiction*. As Lucio Colletti already elaborated 40 years ago it is necessary to distinguish between *real opposition* and *dialectical contradiction* [Colletti, 1975 (1977)]. In the material world forces can point in (at least partially) opposing directions. Each of these forces does not cease to exist if all of the other forces stop. The further development of the system depends on the specific interdependencies between these partially opposing forces, these *real oppositions*. On the other hand the *dialectical contradiction* is an element in the sphere of language. It only can influence the material world via its influence on the actions of the material carriers of language. A dialectic that remains with its self-negation dynamics in the sphere of language can at best produce only new words<sup>21</sup>. To become an evolutionary force language therefore had to be developed into an action-guiding tool shared by its physical carriers. Since only the *homo sapiens* has evolved a language that goes far beyond the simple impulse-reaction mechanism used in all other species, it is possible and advisable to restrict the inversion process to a subset of evolutionary theory, namely to evolutionary political economy<sup>22</sup>. The following reasonable speculation

---

<sup>19</sup> One of the first proponents of this idea, Georgescu-Roegen, after a first being euphoric later in his life rejected the usefulness of entropy in economics. [Georgescu-Roegen, 1971, 1987]

<sup>20</sup> Compare in this context the concept of ‘punctuated equilibria’ used by Per Bak [Bak and Sneppen, 1993]. It was developed somewhat earlier by Stephen J. Gould [Eldridge and Gould, 1972].

<sup>21</sup> A word becomes a concept if it proves its impact on the world outside language.

<sup>22</sup> This statement derives the position of evolutionary political economy as a part of evolutionary theory using an evolutionary argument. It is named ‘*political economy*’ since it treats processes of direct exertion of power

can be added: During each evolutionary stage there is enough time and space for the development of a *network of institutions*. These social devices are tools to *shift disturbances* caused by local real oppositions back in time (e.g. postponing) and in space (e.g. to courtyards). In this way the working of institutions can contribute to the temporary stabilization of the evolutionary stage; it can spread and can prolong its existence. This process will be called *crystal growth*. The introduction of time in the 2<sup>nd</sup> law of thermodynamics now, in the inverted (the evolutionary) perspective, appears as the occurrence of time limits: Real oppositions can be shifted or split into smaller parts by institutional frameworks<sup>23</sup> and the stage of crystal growth can be enlarged. But in the end the real oppositions cannot disappear – and this is the full inversion of the 2<sup>nd</sup> law of thermodynamics – it is their totality of contradictions that enters the shared consciousness of the species, which then can lead to an evolutionary jump, to a social metamorphosis. Several important issues are touched upon by this sketch of a possible inversion of the 2<sup>nd</sup> law of thermodynamics:

- In an evolutionary perspective at least two different time horizons have to be considered: A short horizon within which the processes of crystal growth with its (mainly) stabilizing institutional framework takes place, and a long horizon that enables to include the countervailing destructive force of slowly accumulating real oppositions, which finally lead to an evolutionary jump. This formal requirement should imply the adaption of new formal techniques, e.g. network theory (needed for the description of increasing complexity) and fractal analysis<sup>24</sup> (for adding additional time horizons).
- The network of institutions<sup>25</sup> that is at work during the crystal phase shifts and splits real oppositions, tries to digest the contradictions of this evolutionary stage. In the course of these processes institutions also adapt, to the limits set by this stage, to the problems they have to ‘solve’. What emerges could be called the *culture* of this evolutionary stage. It then is exactly this broad cultural diversity, which constitutes the material needed in preparation for the next evolutionary jump of society. Large scale - historical - social innovation taking place as metamorphosis uses visions produced by new combinations of known older elements. And these older elements are usually fragments of the cultures of bygone crystal growth stages. This evidently is the second essential role that institutional frames play, they contribute to historical experience from which new combinations, new visions for the improvement of society are emerging. They are a historical laboratory of memories on experienced conflict treatment.

---

(politics) as intrinsically interwoven with economic processes embedded in such a political setting. Note that this view is shared with the classical British authors of the 19<sup>th</sup> century. Keynes macroeconomics is only a pale shadow of this much broader approach.

<sup>23</sup> In a sense this is the bright side of what Kafka describes in ‘Der Proceß’ [Kafka, 1915]. Note that there are also contradictions that only *appear* as real oppositions though they are not, and therefore can eventually be completely eliminated.

<sup>24</sup> A good starting point for the understanding of fractal analysis are the memoirs of its most prominent proponent, Benoit Mandelbrot [Mandelbrot, 2012]. A classic text on network theory has been published by Mark Newman [Newman, 2010]. Furthermore a revival of game theory with the original tenets of Neumann and Morgenstern – now called algorithmic game theory – can be expected to provide additional formal tools (compare [Newman and Park, 2003]).

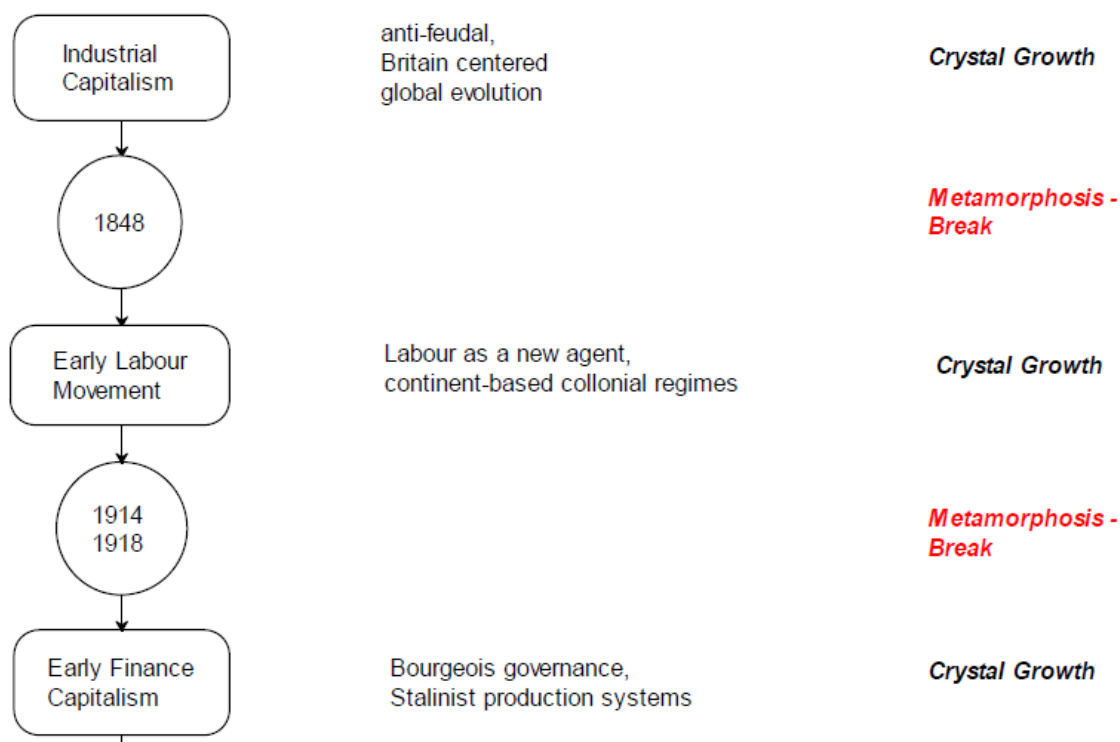
<sup>25</sup> *Institutional economics* therefore is an important subset of evolutionary political economy. Traditionally the phenomena not covered by classical microeconomics and classical microeconomics, lying somewhere at a meso-level, were researched under this title (compare [Dopfer, Foster, and Potts, 2004]). Our definition of institutional economics is more aspiring and goes beyond the purely phenomenological level.

- But metamorphosis to set in needs more than just the still existing mass of accumulated unresolved real oppositions. These explosive circumstances must become visible and interpretable<sup>26</sup> by a relevant share of individuals in the concerned society. Only if a latent metamorphosis is transformed into a vision of a possible radical improvement, a vision held by a share of the population powerful enough to initiate a break, only then the metamorphosis can become manifest. The dialectic occurring as a tool in language to express contradictions thus can be understood as a means to get hold of possible visions, which in turn are a pre-condition for a revolution solving the set of real oppositions.

Each of these topics could only be briefly characterized, nevertheless showing how much work still is waiting for research in evolutionary political economy.

The proposed research program for evolutionary political economy implies work on the formal apparatus that has to be used – a purely narrative style is inadequate - as well as a re-interpretation of history from an evolutionary perspective. A first simple periodization of the last 200 years showing the alternating stages of crystal growth and metamorphosis is shown in figures 1a-1c. Development evidently takes place in a sequence of pushes. Isomorph evolutionary dynamics can be found on different time scales and in different geographical scopes too.

Figure 1a



It is this fractal structure on which the mentioned tools of fractal analysis can be applied. Self-similarity in space can take a look at regions, or at continents, or at the global political economy. Self-

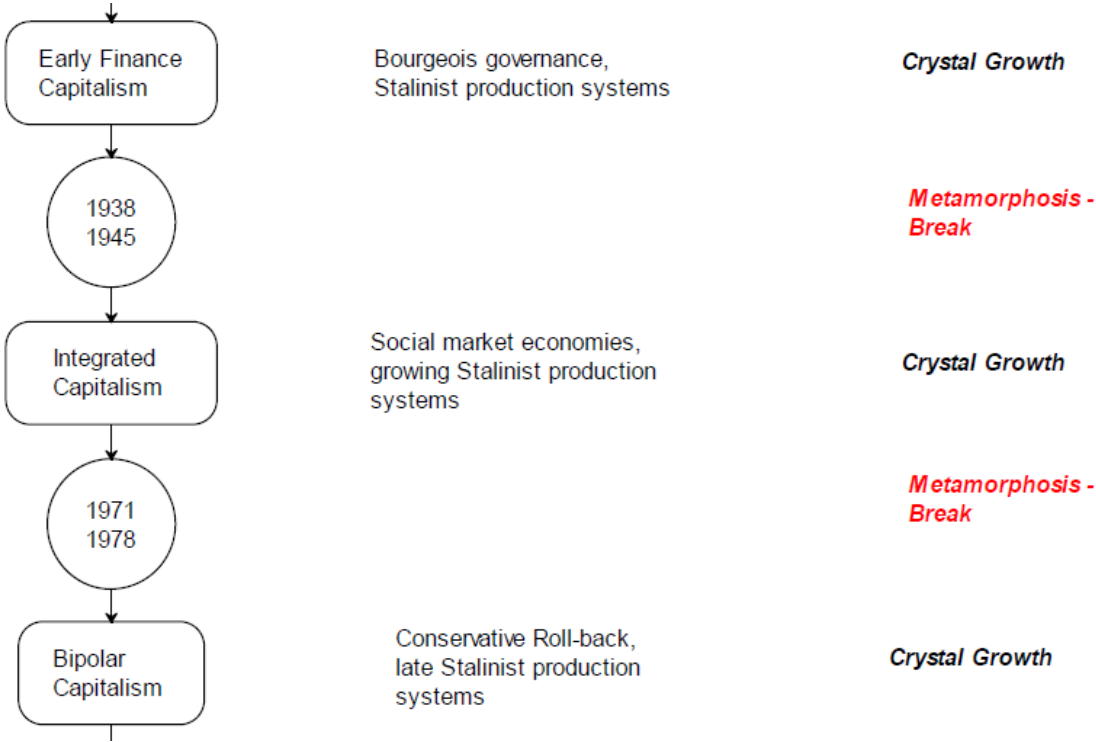
<sup>26</sup> The classic historical example of vision building has been the French Enlightenment that prepared the bourgeois revolution. Karl Marx' efforts as a late representative of enlightenment aimed to stimulate immediately the next revolutionary break, carried by what he saw as the overwhelming part of population, the proletariat.

similarity in time might analyze hours, days, months, years, life times, business demography times, ages etc. During the crystal phase growth mechanisms in both dimensions are emerging. The adjective ‘crystal’ was chosen because - like in a crystal – growth takes place by putting new copies of the structure side by side<sup>27</sup>.

Metamorphosis is different. It often is characterized by a loss of memory, wild efforts to escape from chaos, and application of sometimes far-fetched analogies to arrive at new visions. The break with history might allow the jump to the next evolutionary stage, but it also bears the risk of a quick and final failure of the species.

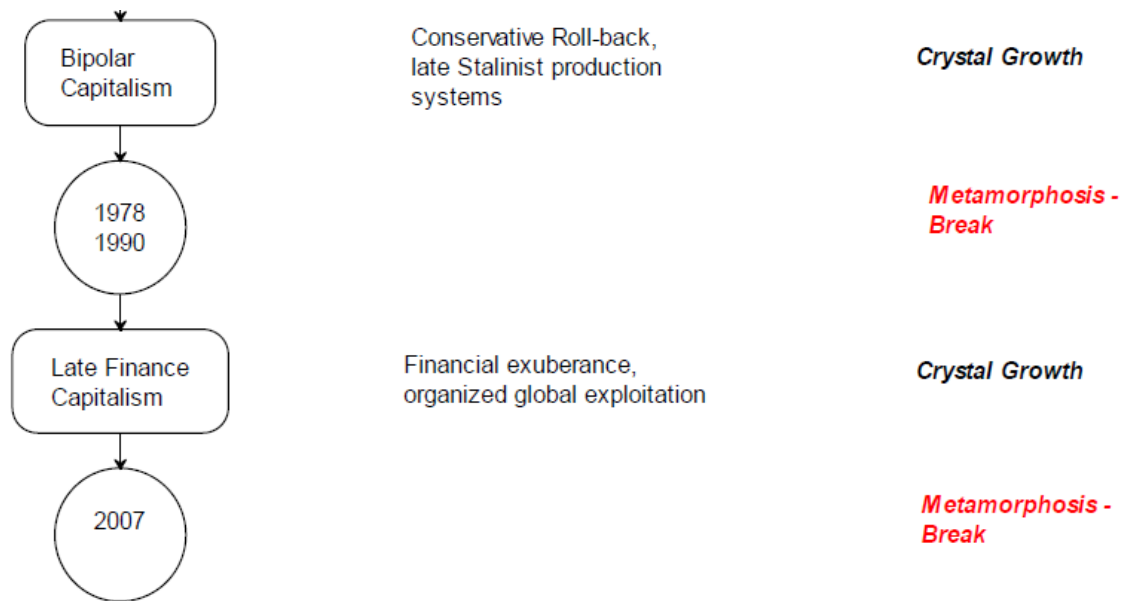
With this preliminary characterization of the object of investigation of evolutionary political economy the pieces of the puzzles to be put together are spread out in front of future ‘organic intellectuals’ (compare Antonio Gramsci’s concept) needed to produce a more complete picture.

Figure 1b



<sup>27</sup> The recent tendency of single human individuals to behave like capitalist firms (organisations formed by many persons) can be interpreted as spatial self-similarity, while reducing daily leisure time is self-similar to reducing life expectancy after retirement in the time domain. Both types of spreading central mechanisms are omnipresent in today’s society and express the (overdue) crystal growth stage.

Figure 1c



### 3. Power

In order to understand the (a) synchronicity of capitalism in time and space – as it appears in political economic phases of crystallization and metamorphosis – we suggest a specific interpretation of institutional change. This understanding is synthesized from the American original institutional economics, Marxist conceptions of institutions as given by the French regulation school and selected works by the French social philosophy of the late 20<sup>th</sup> century. The point of departure for such an analysis is given by “*conflict rather than harmony*” as Gruchy [Gruchy, 1973, p. 623] elaborated once. As already argued in the previous sections, the aesthetics of an EPE approach is given by its focus on *the particular that lies in between*, respectively, the particular object of interest in the matter of conflict-driven institutional change between the poles of politics and economics is clearly the *structure of power*.

As a first aspect of power we aim to highlight institutional, organizational and economic power that rises through growing oligopolies, able to influence the course of national as well as international economic development. In his presidential address to the *American Economic Review* in 1973, Galbraith [Galbraith, 1973, p. 2] famously argued that “*in making economics a non-political subject*” economics “*...destroys its relation with the real world.*” Elsewhere Galbraith [Galbraith, 1967] has developed a concept of economic power that goes beyond the traditional understanding of bargaining power in perfect competition, rather it involves “*...power to impose corporate decisions on consumers, the community, and the state.*” as Gruchy [Gruchy, 1973, p. 643] explains. This aspect of power appears only within an industrialized capitalism where large-scale corporations have absorbed “*...a large share of the nation’s educational and research activities... Having control of much of the nation’s resource of scientific and technological expertise, the large industrial enterprises are in a strong position to influence the course of national economic development.*” (ibid.: 634) Industrial capitalism brought forward different species of corporations as famously observed by Galbraith

[Galbraith , 1967]. *“There is an inner area or sector of large-scale oligopolistic industrial enterprises and an outer sector of small-scale mainly competitive enterprises. The outer area functions very much as does a market economy in the manner indicated in all standard economics textbooks...In the inner heartland of the economy relations between the giant corporations and the state are close, and profit maximization is secondary to the expansion of sales and the enhancement of the corporation’s power and prestige.”* Gruchy [Gruchy , 1973, pp. 629-630]. The calculus of utility maximization may fit well for the small-scale enterprises fighting for survival, because *“economic power is largely contained by the market system”* but *“in the inner sector corporate power extends to the oligopolistic markets, the consumer in them, and the state.”* (ibid.). Conclusively, on the one hand the neoclassical economic apparatus comes too short in their political economic analysis because it builds upon the competitive economy where the size of enterprises is reduced and political as well as legal power minimized in order to get a system with almost no economic power. On the other hand it fails to analyze economic development as a conflict-laden process in a broader Schumpeterian understanding of social development [Schumpeter, 1911]. Today this realm of power faces an additional layer that makes things even more complex, it is the layer of finance. Toporowski [Toporowski , 2010, p. 920] argues that international capital market integration has led to an even newer species of economic corporations, i.e. the *“financially enhanced transnational company”*. This novel type of companies orientates its power not on production output and revenues but on its financial appraisal, its shareholder value. To this extent its operations are at least evenly dependent on financial intermediaries as on traditional production input such as capital and labor, but we can refer to a new mode of accumulation ([Boyer, 2000] and [Tabb, 2010]) as also shown in the previous section . Additionally to finance, we are confronted with a second viable source of power on the institutional and oligopolistic level. This source stems from controlling the co-evolutionary process of society-nature relationships. We follow Kapp [Kapp, 1977] who makes a decisive argument for the economy as an open system. As Berger and Elsner [Berger and Elsner, 2008, p. 83] outline, Kapp’s open system approach emphasizes the *“interaction with the natural and the social systems and focuses both on physical and biological, and institutional interactions between the economic system and its environment.”* He looks into the direct consequences of physical and biological theories of open systems for economics, such as the entropy law. The latter implies that *“...the economic process, from a physical point of view, basically is an entropic transformation since it transforms low into high entropy, which is irrevocable waste”* [Berger and Elsner, 2008, p. 84]. Therefore economic processes are ontologically part of evolutionary change and are thereby irreversible by nature and non-replicable in terms of perfect copies. Otherwise Nicolas Georgescu-Roegen emphasized that life accelerates entropic transformation, and (even more drastically) that *“[t]he present biological spasm of the human species – for spasm it is – is bound to have an impact on our future political organization. ... My reason for the last statement is that, like Marx, I believe that the social conflict is not a mere creation of man without any root in material human conditions”* [Georgescu-Roegen, 1971, p. 306]. Georgescu-Roegen is rather pessimistic about the potential elimination of conflict on multiple levels of social, economic and political organization in the future. He believes in the material basis of social conflict and for that very reason deemed it counter-intuitive that its elimination can be made on behalf of human decision or by the social evolution of mankind. However, Georgescu-Roegen [Georgescu-Roegen, 1971, pp. 316-322] brought some significant conclusions forward related to his historical materialism and the dialectic nature of accumulation processes in political economy. First of all, the idea of boundaries of economics should be given up and, therefore, also the boundaries of the

economic process, a notion that was firstly addressed by the German historical school but made prominent by Marx and Engels. In contrast, “[t]he non-Marxist economists apparently believe that by proving the existence of some natural boundaries for the economic process they will implicitly expose the absurdity of historical materialism and, hence, its corollary: scientific socialism” [Georgescu-Roegen, 1971, p. 316]. In a quite similar vein, Kapp [Kapp, 1977, p. 528] argues that “...the disruption of the environment and its protection raise problems of such complexity that no single academic discipline within its present boundaries can hope to make significant contributions to their solution without at least a basic familiarity with the knowledge of other relevant social and natural sciences. For this reason it is necessary that social and natural scientists concerned with environmental problems and policies engage in transdisciplinary research.” Kapp [Kapp, 1977] mentions the potential power of institutions capable of monitoring the society-nature relationships and capitalizing them. Stirling [Stirling, 2014] highlights this aspect even more in elaborating on the two potential transformations of the political economic system in light of energy choices. In order to understand these complex interdependencies and create counter hegemonies it seems intuitive to follow Georgescu-Roegen (1971) who argued in favor of transforming economics into a dynamic and realist science as the approach of EPE emphasizes. “It is nevertheless true that lessons, perhaps the only substantial ones, on how to transcend the static framework effectively have come from Marx, Veblen and Schumpeter”. [Georgescu-Roegen, 1971, p. 321]

As a second aspect of power we aim to highlight endogenous power and its omnipresence. The starting point for an analysis of transformation dynamics is given by conflict and its power relations rather than harmony and consensus, as indicated by institutionalists [Gruchy, 1973] as well as Marxists ([Hobsbawm, 2012], [Palermo, 2014]). This aspect is revealed by the agonistic nature [Mouffe, 2000] of political struggle that leads to dynamic change and transformation in political economy. Institutional interdependencies between individual actors and social structures lead to endogenous changes in the economy and some of them have even labelled this process evolutionary [Veblen, 1898]. Thorstein Veblen argued that institutional evolution is channelled through cumulative causation of habits of thought. The major driving force behind this process is given by the dichotomy of instrumental versus ceremonial proclivities. These proclivities are conceived as instincts by Veblen that can be either supportive in terms of progress as in the case of the “*instinct of workmanship*”, “*parental bent*” or “*idle curiosity*” or obstruct constructive properties along “*practices of exploit, prowess or mastery (warfare), ownership (material acquisition), and in pecuniary control of industry*” [Tool, 1977, pp. 825-826]. Institutionalists basically argue that the latter human urges or drives are not subject to practical reason but are instead of ceremonial character and may prohibit change, i.e. enforcing institutional inertia. On the contrary, Tool [Tool, 1977, p. 825] explains “*Observing the fact of social change from his anthropological reading, Veblen, as did Karl Marx before him, sought inclusive and continuously applicable theory to explain that change. The evolutionary development of institutional forms appeared to him to parallel the Darwinian account of the evolutionary development of life forms. Veblen sought to identify those modes of thought and behavior which promote or provide for the continuity of culture and those that tend to impair or obstruct developmental cultural continuity.*” The dynamics emerging from the coexistence of ceremonial and instrumental are always conflict-laden and transform political economy, because the former is based in authority and the latter “*denotes performance based upon belief informed by causal reasoning*” as Klein and Miller [Klein and Miller, 1996, p. 268] highlight. The crucial element in this process is given by the habits of thought that are forced to adapt to a continuously changing institutional landscape. As emphasized by



Brown [Brown, 1991, p. 699], the Veblenian habits of thought evolve out of a combination of experience and the societal setting. Facing these circumstances, social and environmental movements seem to be too marginal to invoke any change at all. In particular, social movements face significant problems in making the transition from cultural change to institutional change eventually [Castells 2009, p. 300]. But as highlighted by Laclau and Mouffe [Laclau and Mouffe, 2014] with reference to the Foucauldian understanding of power “...wherever there is power there is resistance... if we recognize that there is a large variety in the form this resistance takes.” Laclau and Mouffe [Laclau and Mouffe, 2014, p. 136]. In this Foucauldian tradition power is understood as bio-power that appears as endogenous population control [Foucault, 1974]. Michel Foucault has dedicated much of his work on the evolution of the sovereignty society to the disciplinary and control society eventually. This aspect is truly relevant for an EPE approach, since the different organizational structures and their power regimes influence the mode of governmentality in society, determining the potential for progress or inertia. Most prominently the transition from the disciplinary to the control society was very exemplary shown by Deleuze [Deleuze, 1993, pp. 254-262] who elaborated on the contradictory word couples of “closure and opening”, “analogous and numeric language”, “factory and enterprise”, “individual and dividual” as well as “energy and information”. Gilles Deleuze has argued that the old sovereign societies dealt with simple “mechanical machines”, the youngest disciplinary societies dealt with “energetic machines” and the newest control societies operate with machines of a third type, i.e. “information machines” Deleuze [Deleuze, 1993, pp. 254-262]. This notion guides us directly from power to our last topic of the EPE approach, that of formal language and method.

#### 4. Methods

It is an analytical device, though one that cannot be circumvented, that an object of investigation and the language used to describe this object of investigation have to be separated. Everyday parole, written language, and more formal languages exist independently of the societies which they try to describe. But they are not pre-existing; they are just results of social evolution. As a consequence evolutionary political economy – taking this argument serious – necessarily sets out to revolutionize the language, which should be used by social scientists<sup>28</sup>. In the moment this probably is the most important impact on existing mainstream theories. Since these theories are stuck in their quest for the correct difference-differential equation system that finally unearths the eternal truth of social interaction – and in doing so freezes intellectual capacities of many well-educated thinkers – evolutionary political economy methods indeed are a scandal. To accept them would immediately devaluate the painfully acquired (useless) knowledge of 90% of leading mainstream academic economists. So take a look at the evolution of methods in the social sciences.

As already elaborated in section 3, each scientific approach is tightly connected with a language and the methods that it is using and applying. The language of classical political economy was nothing else than the precise use of prose until the turn-around towards marginalism in the year of 1874 (compare

---

<sup>28</sup> This is the reason why John von Neumann set out to invent a formal language for the social sciences, i.e. game theory. This is clearly stated at the beginning of his epochal book [Neumann and Morgenstern, 1944], compare also [Hanappi, 2013b].

[Screpanti and Zamagni, 2005]). Scholars aimed to analyse the totality of societal development in this non-formalized language. It seems appropriate considering Karl Marx as the last representative of classical political economy. His work describes the industrial capitalism of his time in such precise terms that with this analysis one could conceive the historical progress as well as the future fall of capitalism. As Marx needs to be considered also as a representative of the enlightenment – why else should he have spent so much effort on writing texts – his science seemed to appear dangerous for the ruling class.

Marginalism, an economic theory developed to oppose Marx as well as the German Historical School – Leon Walras, Stanley Jevons and Karl Menger – needs to be understood as an attempt to radically change the vocabulary - the alphabet - of the classics. Even when we associate some singular marginalists with a kind of socialist thought (e.g. Walras), the marginalist counter revolution was welcomed by the ruling class (the wealthy bourgeoisie had arranged itself with the political leadership of the aristocracy after 1848). The concept of marginal value became the significant core of what is called “economics” thereafter and the political dimension of any economic mechanism was eliminated as already discussed in section 2 in the context of power. It is particularly noteworthy that the language structure of the new economic mainstream shifted from the precise use of prose towards analogies and metaphors drawn from classical physics and its rather simple mathematics of differential calculus at the end of the 19<sup>th</sup> century. Atoms become human individuals and their relations are interpreted as differential equations with individualized psychological variables, compare [Schmidt and Foley, 2002]. It is essential that the concept of social class gets eliminated and the object of investigation of the classics (following Marx, the dynamic development of class conflict) gets replaced by a rather flat model of exchange relations between commodity owners, the dynamics mirroring the equations of mechanics known in the 19<sup>th</sup> century (compare [Milonakis and Fine, 2008]).

To this day, this method of masking the foundational first steps of modelling (i.e. the proper selection of relevant concepts) with a complicated looking formal apparatus is still the most popular dodge of immunizing inadequate theory. This jargon was accompanied by ever more difficult entry barriers to learn it and thereby the references to the real world behind the variables could hardly get reconstructed. In the meantime this cognitive interpretation process is even not considered as necessary anymore for academic careers. The development of microeconomics towards the present pure canon of methods is inherent in the marginalist counter revolution. The intermezzo of Keynes’ revitalized view on the economy as a whole – considered as macroeconomics in his diction<sup>29</sup> – had been owed to the first wave of marginalist analytical failure in terms of economic policy. In the year 1936 follows Keynes’ main work [Keynes, 1936] as a response to the Great Depression. The influence of Keynesian economic policy led furthermore to the development of the first globally acting institutions such as the World Bank and the International Monetary Fund. These institutions become

---

<sup>29</sup> The use of the word ‘macroeconomics’ shows that Keynes just wanted to add a complementary piece of theory to ‘microeconomics’. This amendment was meant to re-introduce the most powerful instrument of the ruling class, the state, into economic analysis, an element that had been eliminated by marginalism. In times of undisputed dominance it had been sufficient for the ruling economic ideology to propagate inadequate models to confuse and to divert critical thinkers. But as soon as a severe crisis occurs ruling ideology also was needed to provide adequate consulting for economic policy. This was exactly what Keynes offered – and some Keynesian models offer today. An additional reason for the popularity of his innovation (even in social democracy circles) was that the labour movement already had conquered several positions in the state apparatus.

important to support and maintain the integrated corporate model of capitalism (compare [Hanappi, 1989]). In parallel new interesting methods were developed meeting the demands of regulation (e.g. Leon Hurwicz' "mechanism design", [Hurwicz, 1973]) as well as the consideration of agents' internal model building (e.g. John von Neumann's "game theory" and the "theory of automata" [Neumann, 1928, 1966]) through transforming them into formal innovations in the mid of the 20<sup>th</sup> century. However the after-war period of crystal growth (compare section 2) leads to a deep consolidation phase of the mathematics preaching mainstream and the initiated formal innovations are faded out – compare [Hanappi, 2013] and [Leonard, 2010] for a detailed history of game theory. As a consequence the unification of micro- and macroeconomics can be considered as the first great methodical project after the war. In phases of crystal growth political intervention is not really on the agenda, so this project, named "microfoundation of macroeconomics", remained on the theoretical level, while economic policy could get along with some simple heuristic rules. Basically the theoretical project failed because of the necessity of strict microeconomic assumptions revealing the complete lack of contact with reality. These assumptions were however necessary as axioms since what was to show was a rigorous mathematical and correct aggregation of microeconomic variables to obtain issues on the macroeconomic level. Optimal welfare properties of a pure market economy had to be proved on that level. This notion holds foremost for assumptions concerned with information processing and communication between agents. The last attempt of saving "microfounded macroeconomics" can be found in the school of rational expectations – assuming almost ridiculous assumptions about the human cognitive apparatus – that became fashionable at the end of the 1970-ties<sup>30</sup>. Since that time mainstream economics got more and more lost in methodical impasses. Still policy-makers usually don't recognize this fact since they are not driven by economic science but by the needs of transnational corporations. A turning point in this game is marked by the creative use of these methods by finance managers who have redirected the uncontrollable exploitation of accelerated centralizing capital towards the stock exchange. The most critical moment of this process is still not too far in the past, in 2008 the fictive game of symbols was flung back to the material world with the real consequences of unpaid debt. In this moment of imminent crisis the cry for adequate theory became louder, wasn't it somehow possible to stabilize integrated capitalism. Keynes gets resurrected, Kalecki and Minsky rediscovered, although their methodical standards and assumptions nowadays only allow just interesting inspiration<sup>31</sup>.

However mostly unrecognized by mainstream economic theory a revolution of methodical as well as methodological possibilities took place in the last 50 years. New language structures move beyond the scope of equilibrium concepts imprisoned in Newtonian mechanics and are largely connected to computational simulation. It is thereby not a coincidence that formal language moved from prose (classical political economy) to mathematics (neoclassical economics) and eventually to algorithmic science (evolutionary political economy). We have illustrated the different categories in table 1.

---

<sup>30</sup> It then has been further supported by the Reagan administration for rather obvious reasons.

<sup>31</sup> For a more detailed discussion of Keynesianism versus Evolutionary Economics compare [Hanappi, 2014b].

LEVEL	PROSE	MATHEMATICS	ALGORITHMS
0	bits	bits	bits
1	words	variables	objects
2	sentences	equations	statements
3	texts	equation systems	programs
4	sets of texts	sets of systems	sets of programs

Table 1: Language structures [Hanappi, 2007]

In particular the agent-based methodology opened a new spectrum of analytical endeavor that emphasizes the generative aspects of modelling actors instead of factors in computational social science [Epstein, 2006]. [Miller and Page, 2007] explain that the scope of bottom-up simulation can be a game changer for analyzing transformation processes in society since it addresses the important role of time and space among other issues (table 2).

Traditional Tools	Agent-Based Objects
precise	flexible
little process	process oriented
timeless	timely
optimizing	adaptive
static	dynamic
1,2, or $\infty$ agents	1,2,..., N agents
vacuous	spacy/networked
homogenous	heterogeneous

Table 2: Modell potential of the bottom-up approach [Miller and Page, 2007, p. 79]

These methods wait for concrete simulation experiments as well as projections of real-utopian visions in evolutionary political economy, because they allow a proper treatment of EPE core concepts such as knowledge, power and social class through the generative approach<sup>32</sup>. First attempts in this direction are given by agent-based models of institutional change (e.g. [Elsner and Heinrich, 2009], [Heinrich, 2014] [Wäckerle et al. , 2014]; compare [Gräbner, 2015] for an introduction and overview) and the novel field of agent-based macroeconomics (e.g. [Cincotti et al. , 2010], [Delli Gatti et al. , 2011], [Riccetti et al., 2013], [Chen et al. , 2014], [Rengs and Wäckerle, 2014], [Seppecher, 2012] with a focus on labor markets, [Dosi et al. , 2013] emphasizing capital goods, banking and innovation, and [Lengnick, 2013] with a benchmark model). The crisis created a scientific space of methodological opportunity motivated by frustration with hegemonic neoclassical economic theory (the economic theory of the ruling class) and it is this vacuum of adequate explanation that can get conquered by evolutionary political economy with novel methods and a concretely defined object of investigation.

<sup>32</sup> In this context Hanappi proposed to understand capitalism as a particular algorithm, the capitalist algorithm, a reframing of the historical discourse into a language that is easily amenable to agent-based simulation (compare [Hanappi, 2013a]).

## 5. Conclusion

The proposal how to understand content and method of evolutionary political economy given above – to call it a definition runs counter the evolutionary character of this scientific discipline – seems to be operational enough to guide future research. Of course, it is rather aspiring since in perspective evolutionary political economy is promising to lead to a unified synthesis of all contemporary social sciences, it aims at being the future mainstream social science. In its critique of today's more or less sophisticated set of mathematical exercises that proclaims to be mainstream economics our approach is not alone. In the last 40 years several (some call them '*heterodox*') approaches have been emerging and it is necessary to position evolutionary political economy (EPE) vis-à-vis these attempts<sup>33</sup>.

With respect to *Institutional Economics* its role as a part of EPE has already been mentioned above. To describe the institutional framework of a crystal growth stage and to show how it is able to stabilize it, while some slow underground contradictions are continuously at work, this difficult task should constitute its main focus<sup>34</sup>. A second important future role that will need more attention is the goal to provide the essence of past ideas for new combinations that lead to visions for future institutional frameworks<sup>35</sup>. That Institutional Economics is only a part of EPE becomes evident as soon as the endogenous entry and exit of institutions comes into play. Where, why and when institutional frameworks emerge can only be *systematically* discussed from a wider perspective<sup>36</sup>, from an EPE perspective.

Another fashionable new approach is *Behavioural Economics*. Its appeal stems mainly from its opposition to the assumption of rational expectations made by the school that (misleadingly) called itself New Classical Macroeconomics (following Robert Lucas and Thomas Sargent, see [Sargent, 1980]). In the context of the methods of EPE described above this critique boils down to the assumption that the agents in ABE models of EPE use internal models that are not necessarily equal to each other and not equal to what afterwards happens in their interaction. For EPE this is a rather trivial issue that (in other words) already had been emphasized by Herbert Simon in his numerous contributions to 'Bounded Rationality' since the 50-ties. Only in contrast to the completely inadequate assumptions of mainstream models *Behavioural Economics* could appear as new, as a 'new' refreshing alternative. But while its main tenet (the existence of independent internal models) is also part of EPE,

---

<sup>33</sup> To highlight differences to the mainstream approach see [Hanappi, 2014a], this also is implicitly done in the previous parts of this paper; compare also [Fine, 2013].

<sup>34</sup> A recent debate on the what should be considered as an institution in the Journal of Institutional Economics, vol 11, No.3, shows how vivid and still in its infancy this field is. From the point of view of EPE the idea to consider an institutional framework as a network of algorithms based on internal models maintained by heterogeneous social agents with the effect of stabilizing a crystal growth phase could be contributed to this discussion. What goes beyond the horizon of the current institutionalist discourse is EPE's insistence on destabilizing, only slowly becoming visible destructive elements of the same stabilizing process, i.e. contradictions in institutions. The intervention of algorithmic language - so far only scarcely imported there as a 'rule-oriented approach' - might clarify dramatically the place of institutionalism as part of EPE.

<sup>35</sup> In this respect research in political science is ahead of Institutional Economics. A good example is a paper on a proposal for rotation in office [Goodin and Lepora, 2015]; see also the following discussion in the same journal.

<sup>36</sup> The consideration of the viability of singular institutions certainly lies within the competences of Institutional Economics, but as soon as social classes as movers of a society that eventually enters a metamorphosis phase enter the stage, as soon as this happens it goes beyond the horizon covered by Institutional Economics. Once metamorphosis has set in Institutional Economics becomes interesting again in its second subaltern role (see above), providing purified historical experience for visions.

it does not provide the same rich context from which EPE *derives* this property of social agents<sup>37</sup>. Where EPE insists on a modelling of information production and perception of information, the standard treatment in *Behavioural Economics* escapes to the measurement of empirically observed actual behaviour, e.g. in ‘Behavioural Finance’. Thus *Behavioural Economics* can provide interesting contributions to EPE with respect to the necessity to model internal model building, but it is running into an impasse if it postulates its single methodological idea of ‘behaviours’ (actions based on different internal models) as an economic paradigm; this idea simply has to be embedded in a broader understanding of the content of the object of investigation. The borderline between *Behavioural Economics* and EPE therefore typically occurs where the characterization of the behaviour of a single type of agent ends; beyond the single profile *Behavioural Economics* remains mute, while EPE starts to become particularly interesting.

An even more interesting case then is *Post-Keynesian Economics*. The pre-fix ‘post’ only indicates that Keynes ideas have more recently been amended by some additional elements. Keynes had re-introduced the state as an agent in economic affairs, which in a sense was a remarkable return to *political* economy. He even had ascribed ‘behaviour’ to the state - that is to the part of the ruling class that was in charge of fiscal and monetary policy. He then proceeded by ascribing ‘behaviour’ to another faction of the ruling class, the firm owners, by assuming that they use an internal model to determine (independently) their investment decisions. In describing the interaction between the two class factions of the ruling class (sometimes plus a third faction of ‘rentiers’) and the workers he went quite a bit towards a prose version of an agent-based story<sup>38</sup>. *Post-Keynesian Economics* tries to further refine this story by looking more closely at the behaviour of these class factions, e.g. by adding capacity utilization as another essential variable in the internal model of firm owners, or by splitting up working class behaviour into employment goals and wage-increase goals. A main objective of Post-Keynesian Economics often is to overcome ‘Bastard Keynesianism’, a variant of Keynes interpretations that started with Hick’s IS-LM modelling in the 40-ties and culminated in the Keynes model found in Thomas Sargent’s book propagating New Classical Macroeconomics. Given the fact that today still most of the macroeconomic models in use are (more or less ‘Bastard’-) Keynesian, demand-driven models the group of Post-Keynesian Economists comes in a variety of formats – closer to these policy-oriented models, or closer to Keynes text, or trying to start anew in a Keynesian spirit. The deficiencies of *Post-Keynesian Economics* in comparison to EPE – forgetting for a moment that in some areas it can contribute important insights to EPE – are basically twofold: (1) The class dynamics, which Keynes observed and started to analyse concern only the decades of the interwar period; and the amendments produced usually also remain within the short-run horizon of Keynes historical political goals. (2) His other theoretical innovation, namely the emphasis on the importance of aggregate demand in an economy of circular flows (with certain accounting identities), focusses only on the need to protect the circular movement from disturbances – any progressive role of ‘creative destruction’, e.g. coming from technological or social revolutions, is out of question<sup>39</sup>. Due to these limits of

---

<sup>37</sup> The role of mass media for internal model building can hardly be over emphasized. To study this type of ideological institutions is an important part of EPE. An interesting recent contribution in this area is [Cunningham, Flew, and Swift, 2015] though they present a somewhat distorted picture of evolutionary economics. For a debate on ideological alienation compare also [Hanappi and Hanappi-Egger, 2014].

<sup>38</sup> Perhaps the special talent of Keynes to give economics a new start was spurred by the fact that he was one of the few famous economists of the past who was not ‘spoiled’ by a proper economic education; his career was that of a politically interested economic practitioner.

<sup>39</sup> Only Richard Goodwin and some of his followers have tried to combine Keynes ideas with Schumpeter’s disequilibrium proposals, see [Hanappi, 2015] for a detailed discussion.

attention – to the long-run as well as to deeper importance of dis-equilibrating actions - the role of contradictions as a moving force of political economy is out of sight. So while many interesting arguments are produced by the increasing number of post-Keynesian economists, they all fail to produce a grand picture of the historical evolution within which they could be fully understood. This is exactly the theoretical environment which EPE tries to produce.

Finally an approach has to be mentioned, which goes back to a scholar who never wanted to form a school: Joseph Alois Schumpeter. *Neo-Schumpeterian Economics* in several respects claims the opposite of Schumpeter's contemporary Keynes. The overwhelming importance of technical progress that Schumpeter - like Marx<sup>40</sup> - tried to root in the social circumstances that enable it, this dominance of the process of innovation is at the centre of neo-Schumpeterian research. Starting with this focus *Neo-Schumpeterian Economics* explores several interesting economic fields: (1) As the driving force of innovation the abstract concept 'entrepreneur' is studied<sup>41</sup>. Note that this driving force acts in opposition to market forces and thus produces contradictions. (2) Since technical advance always emerges in a single economic branch first, then dragging the rest behind in a bandwagon effect, the analysis needs to introduce a sectoral view that produces a more concise picture of the economy. There is the idea that similarly described waves of innovation with different lengths of period are overlaid, a kind of fractal structure, a methodological element also typically for EPE. (3) Schumpeter as well as most Neo-Schumpeterian economists lay heavy emphasis on political implications and economic policy. Research is part of the economic process that is investigated<sup>42</sup>. The Schumpeterian camp thus usually is split along the lines of major social class differences<sup>43</sup>. Again this conscious participation in the political process is shared with EPE. The borderline between *Neo-Schumpeterian Economics* and EPE therefore is a bit blurred. It probably is most visible in the tendency of *Neo-Schumpeterian Economics* to narrow down the problems of evolutionary political economy to questions of innovation – and the 'entrepreneur' carrying out some technical or organisational improvements. While this task certainly has led to an expertise in innovation research, the broader embedding of this special activity – the *historical mission of capitalism*, as Marx and Schumpeter postulate – in the general social evolution often gets out of focus.

As this brief synopsis of its demarcation lines shows, the research program of Evolutionary Political Economy is trying to build a coherent framework out of many valuable theoretical elements to be found in the works of the grand scholars of our discipline. It is aiming at a new theoretical combination, an innovation in theory, which is capable to guide political and economic decision-making; it considers itself as a conscious part of the progressive development of our species. It thus is also part of contemporary class dynamics, in other words it is an eminently political activity – like it, or not.

---

<sup>40</sup> *Neo-Marxism*, as another possible heterodox approach, is not dealt with since it currently cannot be sufficiently identified. The prevailing neo-Ricardian interpretation of some of Marx ideas in the Anglo-Saxon literature has not yet been reconciled with the bulk of other influences of Marx work in other languages and other social science sub-disciplines. Having said this it is nevertheless clear that Marx theory influences and stimulates evolutionary political economy profoundly.

<sup>41</sup> A few researchers in managerial economics still try to find 'entrepreneurial spirits' in exceptional human individuals, despite the fact that Schumpeter himself already had said good-bye to this idea in the 40-ties.

<sup>42</sup> In contrast, 'Bastard Keynesianism' insists on the neutral validity of its arguments - citing Keynes, who once wrote that economists should be like good dentists: Just do the right thing! This statement, of course, is just another communication tool masking intentions to support a certain policy.

<sup>43</sup> Schumpeter himself was on the side of productivity increasing entrepreneurs, with some nostalgic coquetry with respect to the feudal class. In the 80-ties the neo-Schumpeterian *International Schumpeter Society* was clearly divided into two camps, one on the conservative side and one on the socialist side.

Moreover the way necessary to approach its content implies an adjustment of the formal apparatus – even the introduction of newly emerging tools- to be able to describe its phenomena. EPE is forced to participate in the revolution of formal tools of social sciences that currently takes place. That happens with the sciences of non-living systems since 200 years, it now starts to happen with the sciences of living systems. Out of the enormous amount of new formalisms that have mostly emerged from advances in information science and information technology, evolutionary political economy has to select, collect, and combine those techniques that seem to be most appropriate for its content. The feedback from the content will then allow for a progressive dialectic between content and formalization. This is already taking place and the global division of theoretical labour enabled by the internet is starting to create what Antonio Gramsci would have called a global organic intellectual [Gramsci, 1930].

The research program sketched above therefore is part of a global process of emancipation in which emerging knowledge contributes to design the future. It is very urgent to push forward this research program since evolution works with suddenly necessary pushes, with metamorphosis and revolutions. If a blueprint – the vision of a better global society – is not available in time and this blueprint cannot guide the way of class dynamics towards this vision, then it might well be that the species meets a dramatic fall back. This historically observed possibility of biological species has been expressed in much more profane words many decades ago: ‘Socialism or Barbarism’.



## References

- Bak, P. and Kim Sneppen, 1993, *Punctuated equilibrium and criticality in a simple model of evolution*. Physical Review Letters 71 (24): 4083–4086.
- Berger, S. and Elsner W. (2008), European Contributions to Evolutionary Institutional Economics: The Cases ‘Open-Systems Approach’ (OSA) and ‘Cumulative Circular Causation’ (CCC), in Hanappi, H. and W. Elsner (eds.), *Advances in Evolutionary Institutional Economics*, Edward Elgar, Cheltenham, UK.
- Boyer, R. (2000), Is a finance-led growth regime a viable alternative to Fordism? A preliminary analysis, *Economy and Society*, 29 (1), 111-145
- Brown, D. (1991), Thorstein Veblen Meets Eduard Bernstein: Toward an Institutionalist Theory of Mobilization Politics, *Journal of Economic Issues*, 25 (3), 689-708.
- Castells, M. (2009), *Communication Power*, Oxford University Press.
- Chen, Shu-Heng, Chang, Chia-Ling and Wen, Ming-Chang, (2014). Social networks and macroeconomic stability. *Economics: The Open-Access, Open-Assessment E-Journal* 8 (2014-16): 1-40.
- Cincotti, S., Raberto, M. and Teglio, A. (2010). Credit money and macroeconomic instability in the agent-based model and simulator Eurace. *Economics: The Open-Access, Open-Assessment E-Journal* 4: 2010-2026.
- Clausewitz, C.v., 1834, *Vom Kriege (On War)*. Web: <http://www.clausewitz.com/readings/VomKriege1832/TOC.htm#TOC>
- Colletti L., 1975 (1977), *Marxism and Dialectics*, Ullstein Verlag (German edition).
- Cunningham S., Flew T., and Swift A., *Media Economics*, Palgrave MacMillan.
- Darwin, Ch. (1859), *On the Origin of Species*, John Murray, London.
- Deleuze, G. (1993), *Unterhandlungen: 1972-1990*. Suhrkamp, Frankfurt
- Delli Gatti, D., Desiderio, S., Gaffeo, E., Cirillo, P. and Gallegati, M (2011). *Macroeconomics from the Bottom-up*. Springer, Berlin.
- Dosi, G., Fagiolo, G., Napoletano, M. and Roventini, A. (2013). Income distribution, credit and fiscal policies in an agent-based Keynesian model. *Journal of Economic Dynamics and Control* 37(8): 1598-1625.
- Dopfer K., Foster J., and Potts J., 2004, *Micro-meso-macro*, Journal of Evolutionary Economics, Volume 14, Issue 3, pp 263-279.
- Eldridge N. and Gould S., 1972, *Punctuated equilibria: an alternative to phyletic gradualism*, in: "Models in paleobiology", edited by Schopf, TJM Freeman, Cooper & Co, San Francisco, pp. 82-115.
- Elsner, W. and Heinrich, T. (2009). A simple theory of Meso. Co-Evolution of Institutions and platform Size, in: *Journal of Socio-Economics*, Vol. 38(5), pp. 843-858.
- Epstein, J. (2006, ed). *Generative Social Science. Studies in Agent-Based Computational Modeling*. Princeton University Press.
- Fine B., 2013, *Economics - Unfit for Purpose: The Director's Cut*, SOAS Department of Economics Working Paper Series, No. 176, The School of Oriental and African Studies.
- Foucault, M. (2004) [1974], *Geschichte der Gouvernementalität*, 2 Volumes, Suhrkamp, Frankfurt.
- Galbraith, J.K. (1967), *The New Industrial State*, Princeton University Press.
- Galbraith, J.K. (1973), Power and the Useful Economist, *American Economic Review*, 63 (1): 1-11
- Georgescu-Roegen, N. (1971), *The Entropy Law and the Economic Process*, Harvard University Press, Cambridge.
- Georgescu-Roegen, N. (1987), *Entropy*, in Palgrave Dictionary of Economics, pp. 153-156.
- Goodin R. and Lepora Ch., 2015, *Guaranteed Rotation in Office: A 'New' Model Of Democracy*, The Political Quarterly, Vol. 86, No. 3, July-September.
- Gould, S.J. (2002), *The Structure of Evolutionary Theory*, Harvard University Press.
- Gräbner, C. (2015), Agent-based computational models – a formal heuristic for institutionalist pattern modelling? *Journal of Institutional Economics*, published online: DOI: <http://dx.doi.org/10.1017/S1744137415000193>
- Gramsci A., 1930, *Prison Notebooks*, in: Further Selections from the Prison Notebooks, Electric Book Company Ltd, London, 1999.
- Gramsci, A. (2012) [1971], *Selections from the Prison Notebooks*, International Publishers.

- Gruchy, A.G. (1973), Law, Politics, and Institutional Economics, *Journal of Economic Issues*, 7 (4), 623-643.
- Hanappi H., 1989, *The Stages of Industrial Capitalism*, in: Technological and Social Factors in Long Term Fluctuations, edited by Vercelli A., DiMatteo M., and Goodwin R., Springer Publishers.
- Hanappi H., 2007, *On the Nature of Knowledge*, MPRA Paper No. 27615
- Hanappi H., 2013a, *Money, Credit, Capital, and the State, On the evolution of money and institutions*, in: Buenstorf G. et al. (eds), 'The Two Sides of Innovation. Economic Complexity and Evolution', Springer, pp. 255-282.
- Hanappi H., 2013b, *The Neumann-Morgenstern Project*, book chapter in the book 'Game Theory Relunched' edited by H. Hanappi, Intech publishers (UK). Web: <http://www.intechopen.com/books/game-theory-relaunched>
- Hanappi H., 2014a, *Bridges to Babylon. Critical Economic Policy: From Keynesian Macroeconomics to Evolutionary Macroeconomic Simulation Models*, book chapter in 'Economic Policy and the Financial Crisis' edited by Lukasz Mamica and Pasquale Tridico (Routledge).
- Hanappi H., 2014b, *Evolutionary Political Economy in Crisis Mode*, *Journal of Economics and Statistics*, vol. 234/2+3 - 2014, pp. 422-440.
- Hanappi H., 2015, *Schumpeter and Goodwin*, *Journal of Evolutionary Economics*, vol. 25/no 1.
- Hanappi H. and Hanappi-Egger E., 2014, *Social Identity and Class Consciousness*, MPRA Paper No. 60491. Web: <http://mpra.ub.uni-muenchen.de/60491/>
- Heinrich, T. (2014), Standard Wars, Tied Standards, and Network Externality Induced Path Dependence in the ICT Sector, *Technological Forecasting and Social Change*, 81: 309–320.
- Hobsbawm, E. (2012), *How to Change the World – Tales of Marx and Marxism*, Abacus, London.
- Hurwicz L., 1973, *The Design of Mechanisms for Resource Allocation*, *AER*, vol. 63, issue 2, pp. 1-30.
- Kafka F., 1915, *Der Proceß*, (The Trial, also as film by Orson Welles), manuscript.
- Kapp, K.W. (1977), Environment and Technology: New Frontiers for the Social and Natural Sciences, *Journal of Economic Issues*, 11 (3), 527-540.
- Klein, P.A. and Miller E.S. (1996), Concepts of Value, Efficiency, and Democracy in Institutional Economics, *Journal of Economic Issues*, 30 (1), 267-277
- Laclau, E. and Mouffe C. [1985] (2014), *Hegemony and Socialist Strategy: Towards a Radical Democratic Politics (2nd ed.)*, Verso, London; New York.
- Lengnick, M. (2013). Agent-based macroeconomics: A baseline model. *Journal of Economic Behavior & Organization* 86 (C): 102-120.
- Leonard R., 2010, *Von Neumann, Morgenstern, and the Creation of Game Theory*, Cambridge University Press.
- Mandelbrot B. , 2012, *The Fractalist. Memoir of a Scientific Maverick*, Pantheon Books, New York.
- Marx, K. (2001) [1890], *Das Kapital - Kritik der politischen Ökonomie*, Erster Band, Erstes Buch: *Der Produktionsprozess des Kapitals*, Karl Dietz Verlag Berlin.
- Miller J.H. and Page S.E. (2007), *Complex Adaptive Systems: An Introduction to Computational Models of Social Life*, Princeton University Press.
- Milonakis, D. and Fine, B. (2008), *From Political Economy to Economics: Method, the Social and the Historical in the Evolution of Economic Theory*, Abingdon: Routledge.
- Mouffe, C. [2000] (2009), *The Democratic Paradox*, Verso, London; New York.
- Neumann J., 1928, *Zur Theorie der Gesellschaftsspiele*. in: *Mathematische Annalen*, Band 100, 1928, S. 295–320.
- Neumann J., 1966, *Theory of Self-Reproducing Automata*, in Burks, A. W., ed., University of Illinois Press.
- Neumann J. and Morgenstern O., 1944, *Theory of Games and Economic Behavior*, Princeton University Press, Princeton.
- Newman M., 2010, *Networks*, Oxford University Press.
- Newman M. and Park J., 2003. *Why social networks are different from other types of networks*, Working Paper of the Santa Fe Institute.
- Palermo, G. (2014), The economic debate on power: a Marxist critique, *Journal of Economic Methodology*, 21 (2): 175-192.
- Rengs, B. and Wäckerle, M. (2014), A Computational Agent-Based Simulation of an Artificial Monetary Union for Dynamic Comparative Institutional Analysis. *Proceedings of the 2014 IEEE*

- Conference on Computational Intelligence for Financial Engineering & Economics (CIFEr)*: 427-434. DOI: 10.1109/CIFEr.2014.6924105: 427 – 434.
- Sargent Th., 1980, *Macroeconomic Theory*, Academic Press, Boston.
- Schrödinger E., 1944, *What is Life? The Physical Aspect of the Living Cell*, MacMillan Publishers.  
Web: [whatislife.stanford.edu/LoCo\\_files/What-is-Life.pdf](http://whatislife.stanford.edu/LoCo_files/What-is-Life.pdf)
- Schumpeter, J.A. (1997) [1911], *Theorie der wirtschaftlichen Entwicklung*, 9th edition, Duncker & Humblot, Berlin, D.
- Screpanti, E. and Zamagni, S. (2005), *An Outline of the History of Economic Thought*, Oxford: Oxford University Press.
- Seppacher, P. (2012). Flexibility of Wages and Macroeconomic Instability in an Agent-Based Computational Model with Endogenous Money. *Macroeconomic Dynamics* 16 (s2): 284-297.
- Simon, H.A. (1996), *The Sciences of the Artificial*, 3rd edition, MIT Press, Cambridge, UK.
- Smith E. and Foley D., 2002, *Classical thermodynamics and economic general equilibrium theory*, Working Paper of the Santa Fe Institute.
- Stirling, A. (2014), Transforming power: Social science and the politics of energy choices, *Energy Research & Social Science*, 1, 83-95.
- Tabb, W.K. (2010), Financialization in the contemporary social structure of accumulation, in McDonough T., Reich, M. und Kotz, D.M. (eds.) (2010), *Contemporary Capitalism and Its Crises. Social Structure of Accumulation Theory for the 21<sup>st</sup> Century*, Cambridge University Press.
- Theil H., 1967, *Economics and Information Theory*, North-Holland Publishers, Amsterdam.
- Tool, M.R. (1977), A Social Value Theory in Neoinstitutional Economics, *Journal of Economic Issues*, 11 (4), 823-846
- Toporowski, J. (2010), The transnational company after globalisation, *Futures* 42: 920-925.
- Veblen, Th. (1898), Why is economics not an evolutionary science?, *The Quarterly Journal of Economics*, Vol. 12
- Wäckerle, M. (2014), *The Foundations of Evolutionary Institutional Economics: Generic Institutionalism*, Abingdon: Routledge.
- Wäckerle, M., Rengs, B. and Radax, W. (2014), An Agent-Based Model of Institutional Life-Cycles, in: *Games*, Vol. 5 (3), pp. 160-187.